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ful and painstaking comparison with corresponding features in the religious life of other peoples of every degree of culture all over the globe.

It is scarcely necessary, considering from what press it comes, to add that the typographical get-up of Mr. Lockyer's book is exceedingly good. The paper is excellent, the print is large and clear, and the illustrations well chosen and finely reproduced. In a few instances a plate is laterally reversed, or a pair of reference letters interchanged, but the errors are quite unimportant ones and readily detected.

As the work is one of the most important of the year, and on a subject which is surrounded with obscurities and technicalities, the literary public may well congratulate itself on having it in so attractive and readable a form, and both author and publisher deserve much credit for the result.

S.V.

FROM THE GREEKS TO DARWIN. An Outline of the Development of the Evolution Idea. By *Henry Fairfield Osborn, Sc. D.* New York and London : Macmillan & Co. 1894. Pp. 259. Price, \$2.00.

The present volume forms the opening number of the Columbia University Biological Series edited by Henry Fairfield Osborn, Professor of Biology in Columbia College, and formerly Professor in Princeton. The work is dedicated to Dr. McCosh, and is one of the many good results of the impetus that that lamented teacher gave to the study of philosophy in America. The volume grew out of lectures first delivered in Princeton in 1890 upon the period between Buffon and Darwin, and completed in a fuller course at Columbia in 1893. The chief object of the author is to bring forward the many strong and true features of pre-Darwinian evolution, usually passed over or misunderstood, to place before the reader the evidence of continuity in the development of the evolution idea, and to trace the lines of this development through the history of philosophy. An excellent idea in the plan of the lectures is that of the "environment" of the evolution idea. Professor Osborn sees, and clearly states, that ideas are a product of nature; that they grow and develop like living organisms and that the general features of evolution may be traced in them also. "The final conception of Evolution is to be regarded as a cluster of many subsidiary ideas, which slowly evolved in the environment of advancing human knowledge. Like an animal or plant made up of different parts which have been added one by one along the ages, we can take up this history as we should a bit of biological research; consider the idea as living and still growing, and seek the first stages of each of its parts." The title of the work is a happy one, and seems to have been suggested by Zeller's *The Greek Predecessors of Darwin*. The excellent bibliography appended to the lectures shows that Professor Osborn has employed the best obtainable sources in the philosophy of the subject, and although he lays little claim to originality in the conception and execution of the work, his reputation as a practical biologist leads the reader to expect that his material will be placed under new and instructive points of view.

Throughout the whole history of philosophy and science, the speculations upon

the origin of life and the nature of the organic world form a continuous whole. The influence of early upon later thought is greater than is usually believed, and especially to the Greeks Darwin owes more than has been recognised or at least been explicitly stated. The evolution-law was not reached by any decided leap, but by the progressive development of a large group of subordinate ideas. To trace these lesser ideas to their sources, and to bring the comparatively little known early evolutionists into their true relief is, as above stated, the task which Professor Osborn sets himself. The non-appreciation of the continuity of evolution thought, with the lack of sense of proportion as to the original merits of different writers, he finds to be the greatest defects in the historical literature of the subject. For example, he thinks that Haeckel has far overstated the merits of Oken, who shines forth brightly in certain passages, but goes under a cloud in others. His own method is to get an estimate of each author as a whole before showing his connexion with the idea in individual and isolated points. To take two other instances, Krause has placed Erasmus Darwin over Lamarck without sufficient consideration, and Huxley has treated Treviranus and Lamarck with almost equal respect, while it is Professor Osborn's opinion that Treviranus in spite of his high merits is hardly to be compared with Lamarck, so far as real solid contributions to the modern ideas of evolution are concerned.

In the Introduction we have an outline of the whole development of the evolution idea. Taking Bacon's dictum regarding the anticipation and interpretation of nature as his guide the author finds the following stages in the discovery of the law, *to-wit* : (1) The anticipation of nature—Greek evolution—which beginning with the old Greek physiologists continues through Arabic philosophy to mediæval Christian theology; (2) the interpretation of nature—modern evolution—exhibited in the emancipation of botany and zoölogy from Greek traditions and in the speculations of the philosophers of the seventeenth and eighteenth centuries; (3) modern inductive evolution which embraces two periods, that from Buffon and St. Hilaire, marked by the rapid extension of the natural sciences, and that of Darwin and Wallace, when evolution is established inductively and deductively as a law of nature.

The early Greeks were mainly deductive or *a priori* in their scientific method. This also characterised mediæval and even modern thought upon evolution. The facts strangely contradict the current views of the history of this idea. The very men who recommended induction practised it least successfully. Some early Christian Fathers were more liberal and rational than some very modern precursors of evolution. Augustine ridiculed the error of searching the Scriptures for laws of nature, and gave a broad and modern interpretation of the first chapter of Genesis, whilst the theory of special creation, which, we might say, he rejected, was held by eminent naturalists as late as the nineteenth century. The accumulation of the natural evidences of evolution, which fell mainly in the third period, was the work of centuries. First came correct ideas of structure or comparative morphology, then the knowledge of function or physiology, then true ideas of individual development

or embryology, finally, natural environment began to be studied and the facts of distribution, and with all grew palaeontology. Analogy, homology, adaptation, degeneration were noticed, and lastly, but chiefly, the doctrine of abiogenesis which formed one of the greatest impediments to the growth of the true evolution idea, was overthrown, and natural causation substituted for supernatural in the world of organisms.

Looking over the contributions of the Greeks to the idea of evolution, we find in Thales the idea of the aquatic or marine origin of life; in Anaximander, who is termed by Haeckel the prophet of Kant and Laplace in cosmogony, and of Lamarck and Darwin in biology, the dim notion of survival and persistence in difficult circumstances, and the doctrine of abiogenesis. In Anaximenes and Diogenes of Apollonia we discover the idea of a primordial terrestrial slime—the prototype of Oken's *Urschleim*—from which animals are directly derived abiogenetically. In the teachings of Empedocles is found the germ of the theory of the survival of the fittest or of natural selection. Empedocles modified the abiogenetic hypothesis, and adumbrated, so to speak, the following truths of modern evolution: "First, that 'the development of life was a gradual process; second, that plants were evolved 'before animals; third, that imperfect forms were gradually replaced (not succeeded) by perfect forms; fourth, that the natural cause of the production of perfect forms was the extinction of the imperfect." Empedocles's position on these matters is very important, and greatly influenced later thought. His view of adaptation as applicable only to organisms as a whole was extended by Democritus to embrace the adaptation of single structures in individual organs. We next come to Aristotle, who of all the ancients, and also of all inquirers till most recent times, showed the clearest insight into the nature of the problem of life. Aristotle's importance has been strangely overlooked, and it is one of Professor Osborn's chief claims to place him in his right light. Aristotle's knowledge of natural history was for his time marvellous; he may be said to have created the science. The centuries preceding him yielded nothing but vague speculation. "I find no basis prepared," he says. "No models to copy. Mine is the first step." "He was the first to conceive of a genetic series, and his conception of a single chain of evolution from the polyps to man was never fully replaced until the beginning of this century." He first studied lower types. He distinguished five hundred species of mammals, birds, and fishes. His biological essays show that he fully recognised analogies between the different organs, he perceived the unity of plan or type in certain classes of animals; he rightly conceived of life as the function of the organism, not as a separate principle; he anticipated Harvey's doctrine of epigenesis; he perceived the forces of hereditary transmission, of atavism or reversion, as also the principle of compensation of growth. Moreover, his main ideas upon evolution seem to have been drawn from observation. Aristotle believed in a complete gradation of nature, a progressive development corresponding with a progressive life of the soul. We have spoken of his chain of evolution beginning with polyps and end-

ing in man. The progressive development mentioned was affected by a sort of metaphysical principle which has not yet disappeared from science, and which in modern phraseology we should call an "internal perfecting tendency," which drives organisms progressively forward into more perfect types. Certain quoted passages contain, as Professor Osborn thinks, "absolute evidence that Aristotle had substantially the modern conception of the evolution of life, from a primordial, soft mass of living matter to the most perfect forms, and that even in these he believed evolution was incomplete, for they were progressing to higher forms." He combated Empedocles's suggestion of the survival of adapted and extinction of inadapted beings; had he accepted Empedocles's hypothesis, says Professor Osborn, he would have been the literal prophet of Darwinism.

There is little of interest in the subsequent ancient philosophers. Epicurus's chief merit is to have established the natural *versus* that of supernatural causation. Lucretius did nothing but restate the doctrines of Empedocles; we cannot speak of him as an evolutionist, "in the sense of gradual development by descent." Coming to the theologians, we find only in Gregory of Nyssa and in St. Augustine the attempt at a naturalistic interpretation of the order of creation. "The reaction against the scientific reading of Genesis came when Christian theology shook off Aristotelianism. . . . No advance whatever in a development of the evolution idea was made in this long period," which lasted until 1600, except among the Arabs.

In passing to what Professor Osborn calls the natural philosophers we reach the period of the rise of natural science in the sixteenth, seventeenth, and eighteenth centuries. Here we have three classes of writers, the "Naturalists," the "Speculative Evolutionists," and the "Natural Philosophers." The first built up the future materials of evolution-thought, the second promulgated only unsound metaphysical ideas, the third, including such men as Bacon, Descartes, Leibnitz, Hume, Kant, Lessing, Herder, and Schelling, really gave the modern methods of studying the evolution problem. They perceive the importance of the principle of variation, gradations of type, as also the necessity of a general evolution of life. We need not tarry long with these men, but only say a word of Kant. "The finest and the fullest expression of evolution in philosophical literature is found in Kant." In a famous passage in Kant, now well known, "we can trace the influence," says Professor Osborn, "of every earlier philosopher from Aristotle down, and recognise the problems which have faced every later one." Also in that giant of thought, Herder, we find much. "Herder clearly formulated the doctrine of *unity of type*, which prevailed among the evolutionists of the period immediately following."

The writings and achievements of the evolutionists of the eighteenth century are in the main familiar. Still, a few points may be noticed. Referring to the common overestimate of Oken as a prophet of modern evolution, Professor Osborn says; "In fact, when we analyse his contributions, we find that they actually represent the last survivals of Greek evolution with a veneer of eighteenth-century progress. When we read him through and through we see that he is about as

"truly an anachronism as old Claude Duret of 1609"—Claude Duret, who told the story of a tree in Scotland, from which falling leaves striking water on one side were transformed into fishes and striking land on the other were turned into birds. Charles Bonnet (1720-1793), though not an evolutionist, is remarkable as the author of the term. Strange to say, it meant then not evolution but something else, the term abiogenesis corresponding more to the meaning of the modern idea. Of the great naturalists, Linnæus was important merely as the founder of the "School of Facts," of which Cuvier was later the leader. The merit of Buffon, who "may be called the naturalist founder of the modern form of the evolution theory," was his suggestiveness. "He may be said to have asked all the questions which were to be answered in the course of the succeeding century." In Erasmus Darwin much of interest is found. For example, "the first clear and "definite statement of the theory of the transmission of acquired characters considered as one of the factors of evolution."

Chapters V and VI of the work are entitled, respectively, "From Lamarck to St. Hilaire" and "Darwin." "Lamarck (1744-1829), as the founder of the complete "modern theory of Descent, is the most prominent figure between Aristotle and Darwin." Professor Osborn's discussion of his achievements is full and fair. Goethe, too, comes in for an appreciative estimate, but Treviranus, the author thinks, is overrated, not going beyond Buffon and virtually taking the position held much earlier by Goethe. Of Darwin nothing need be said here. The author closes with these words: "It is for the future to determine whether the predecessors of Darwin "and Darwin himself, in the principle to which he gave a life of thought, have fully "answered the old, old problem, or whether we shall look for still another Newton "in our philosophy of Nature."

In Professor Osborn's work, we gain a very fair idea of the movement of the evolution idea and of its significance, and it may be cordially recommended to those who wish to obtain a preliminary survey of the subject. It is remarkably free from typographical errors¹ which is very important in such a work, and is printed on good paper in a fine, large type. It is to be hoped that the works which follow it will be as useful and interesting.

T. J. McC.

AMPHIOXUS AND THE ANCESTRY OF THE VERTEBRATES. By Arthur Willey, B. Sc.
With a Preface by Henry Fairfield Osborn. New York and London: Macmillan & Co. 1894. Pp., 316. Price, \$2.50.

The present treatise constitutes the second volume of the Columbia University Biological Series, opened by Professor Osborn's *History of the Evolution Idea*, and although of a technical and special nature, is, by the subject which it treats, of high general interest and importance. That subject is the ancestry of the vertebrates

¹On page 113 the author refers to a paper of Maupertuis on "The Conservation of Energy Doctrine." Maupertuis never considered that subject; what is meant is the principle of least action.